

What is Claimed Is:

1. A low noise, high areal recording density, perpendicular magnetic recording medium, comprising:
 - (a) a non-magnetic substrate having a surface; and
 - (b) a layer stack formed over said substrate surface, said layer stack comprising, in overlying sequence from said substrate surface:
 - (i) a magnetically soft underlayer;
 - (ii) at least one non-magnetic interlayer; and
 - (iii) a CoCr-based, magnetically hard perpendicular recording layer;
- 10 wherein the compositions of said at least one non-magnetic interlayer and said CoCr-based, magnetically hard perpendicular recording layer are selected to provide said medium with a negative nucleation field H_n , remanent squareness of about 1, and high coercivity of at least about 5,000 Oe.
2. The magnetic recording medium as in claim 1, wherein:
said at least one non-magnetic interlayer (ii) is not more than about 10 nm thick.
3. The magnetic recording medium as in claim 2, wherein:
said at least one non-magnetic interlayer (ii) comprises a layer of Ru, a Ru/CoCr bi-layer structure, or a Ru/CoCrX bi-layer structure, where X is at least one element selected from the group consisting of Pt, Ta, Mo, Ti, W, Ag, and Pd.
4. The magnetic recording medium as in claim 3, wherein:
said at least one non-magnetic interlayer (ii) comprises a Ru/CoCr bi-layer structure, wherein the Cr content of the CoCr portion of said Ru/CoCr bi-layer structure is from about 37 to about 43 at. %.

5. The magnetic recording medium as in claim 3, wherein:
said at least one non-magnetic interlayer (ii) comprises a Ru/CoCrX bi-layer structure, wherein the Co content of the CoCrX portion of said Ru/CoCrX bi-layer structure is from about 57 to about 63 at. %.
6. The magnetic recording medium as in claim 1, wherein:
said CoCr-based, magnetically hard perpendicular recording layer (iii) is from about 10 to about 30 nm thick and comprises a CoCrPt alloy.
7. The magnetic recording medium as in claim 6, wherein:
said CoCr-based, magnetically hard perpendicular recording layer (iii) comprises a CoCrPt alloy with a Pt content from about 14 to about 21 at. %.
8. The magnetic recording medium as in claim 7, wherein:
said CoCrPt alloy comprises about 20 at. % Cr and about 15 at. % Pt.
9. The magnetic recording medium as in claim 1, wherein:
said magnetically soft underlayer (i) is from about 150 to 400 nm thick and comprises a material selected from the group consisting of: Ni, NiFe (Permalloy), Co, CoZr, CoZrCr, CoZrNb, CoTaZr, CoFe, Fe, FeN, FeSiAl,
5 FeSiAlN, FeTaC, FeAlN, FeTaN, CoFeZr, and FeCoB.
10. The magnetic recording medium as in claim 9, wherein:
said magnetically soft underlayer (i) comprises FeCoB.
11. The magnetic recording medium as in claim 1, wherein:
said non-magnetic substrate (a) comprises a material selected from the group consisting of Al, NiP-plated Al, Al-Mg alloys, other Al-based alloys, other non-magnetic metals, other non-magnetic alloys, glass, ceramics, polymers, glass-ceramics, and composites and/or laminates thereof.
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12. The magnetic recording medium as in claim 1, further comprising:

(c) a protective overcoat layer over said magnetically hard perpendicular recording layer (iii); and

(d) a lubricant topcoat over said protective overcoat layer.

13. The magnetic recording medium as in claim 1, wherein:

said non-magnetic substrate (a) comprises a material selected from the group consisting of Al, NiP-plated Al, Al-Mg alloys, other Al-based alloys, other non-magnetic metals, other non-magnetic alloys, glass, ceramics, polymers, glass-ceramics, and composites and/or laminates thereof; and

5 said layer stack (b) comprises:

a magnetically soft underlayer (i) from about 150 to 400 nm thick and comprised of FeCoB;

10 a non-magnetic interlayer (ii) not greater than about 10 Å thick, comprised of a Ru layer, a Ru/CoCr bi-layer structure, or a Ru/CoCrX bi-layer structure, wherein X is at least one element selected from the group consisting of Pt, Ta, Mo, Ti, W, Ag, and Pd; and

15 a magnetically hard, perpendicular magnetic recording layer (iii) about 25 nm thick and comprised of a CoCrPt alloy with about 20 at. % Cr and about 15 at. % Pt;

wherein said medium exhibits a high coercivity of about 5,000 Oe, a remanent squareness of about 0.98, and a negative nucleation field H_n of at least about -1,250 Oe.

14. A method of manufacturing a low noise, high areal recording density, perpendicular magnetic recording medium, comprising the steps of:

(a) providing a non-magnetic substrate having a surface; and

5 (b) forming a layer stack over said substrate surface, comprising steps for forming in overlying sequence from said substrate surface:

(i) a magnetically soft underlayer;

- (ii) at least one non-magnetic interlayer; and
 - (iii) a CoCr-based, magnetically hard perpendicular recording layer;
- 10 wherein step (b) includes selecting the compositions of said at least one non-magnetic interlayer and said CoCr-based, magnetically hard perpendicular recording layer to provide said medium with a negative nucleation field H_n , remanent squareness of about 1, and high coercivity of at least about 5,000 Oe.

15. The method according to claim 14, wherein:
- step (a) comprises providing a non-magnetic substrate comprised of a material selected from the group consisting of Al, NiP-plated Al, Al-Mg alloys, other Al-based alloys, other non-magnetic metals, other non-magnetic alloys,
 - 5 glass, ceramics, polymers, glass-ceramics, and composites and/or laminates thereof;
 - step (b)(i) comprises forming said magnetically soft underlayer as an about 150 to about 400 nm thick layer comprised of a material selected from the group consisting of: Ni, NiFe (Permalloy), Co, CoZr, CoZrCr, CoZrNb, CoTaZr,
 - 10 CoFe, Fe, FeN, FeSiAl, FeSiAlN, FeTaC, FeAlN, CoFeZr, and FeCoB;
 - step (b)(ii) comprises forming said at least one non-magnetic interlayer at a thickness not greater than about 10 nm and comprised of a layer of Ru, a Ru/CoCr bi-layer structure, or a Ru/CoCrX bi-layer structure, wherein X is at least one element selected from the group consisting of Pt, Ta, Mo, Ti, W, Ag,
 - 15 and Pd; and
 - step (b)(iii) comprises forming said CoCr-based, magnetically hard perpendicular recording layer as an about 10 to about 30 nm thick layer comprised of a CoCrPt alloy with a Pt content from about 14 to about 21 at. %.

16. The method according to claim 15, wherein:

step (b)(i) comprises forming a magnetically soft underlayer comprised of FeCoB;

5 step (b)(ii) comprises forming a non-magnetic interlayer wherein the portion of Co in the Ru/CoCr bi-layer structure or Ru/CoCrX bi-layer structure is from about 57 to about 63 at. %; and

step (b)(iii) comprises forming a magnetically hard, perpendicular magnetic recording layer (iii) about 25 nm thick and comprised of a CoCrPt alloy with about 20 at. % Cr and about 15 at. % Pt;

10 whereby said medium exhibits a high coercivity of about 5,000 Oe, a remanent squareness of about 0.98, and a negative nucleation field H_n of at least about -1,250 Oe.

17. The method according to claim 14, wherein:

each of steps (b)(i), (b)(ii), and (b)(iii) for respectively forming said magnetically soft underlayer, said non-magnetic interlayer, and said magnetically hard, perpendicular recording layer comprises DC magnetron sputtering; and the 5 method further comprises heating said non-magnetic substrate between steps (b)(i) and (b)(ii) and between steps (b)(ii) and (b)(iii).

18. The method according to claim 14, further comprising steps of:

(c) forming a protective overcoat layer over said magnetically hard perpendicular recording layer; and

(d) forming a lubricant topcoat over said protective overcoat layer.

19. A low noise, high areal recording density, perpendicular magnetic recording medium, comprising:

(a) a perpendicular magnetic recording layer comprised of a CoCr alloy; and

5 (b) means for providing said medium with a negative nucleation field
H_n, remanent squareness of about 1, and high coercivity of at least about 5,000
Oe.

20. A disk drive comprising the perpendicular magnetic recording medium of claim 1.

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